Air Carrier Aircraft In-Flight Icing Operational Issues and Concerns

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In 1995, following the October 1994 aircraft icing accident near Roselawn, Indiana, ALPA wrote and distributed its position paper,

Inflight Structural Icing:
An Operational Analysis and Global Approach

That paper identified the following operational problems with inflight structural icing:

•FAR 25 does not specify handling and performance standards for certification for flight in any icing environment

•FAR 25, Appendix C, the icing environment defined for use in certification, does not address freezing drizzle or freezing rain

•There is no objective index of in-flight icing severity

•Methods of forecasting of inflight icing are not capable of useful resolution in space, time or parametry

•A serious disharmony exists between the criteria used for certification and the criteria used for aircraft dispatch and operation in icing conditions

How Have We Done Since 1995?

CERTIFICATION

- FAR / JAR 25.21(g) has been drafted, and published by NPA by the JAA, and is in internal coordination in the FAA. This rule and associated advisory material provide handling and performance standards for flight in Appendix C icing conditions.

- The Ice Protection Harmonization Working Group, which is organized under the FAA's Aviation Rulemaking Advisory Committee and includes representatives of many international organizations & companies, has drafted an Appendix X to describe inflight icing due to freezing drizzle and freezing rain. Other ARAC working groups are working to incorporate App X within all transport aircraft certification rules. Final work on these proposals is due to the FAA & JAA by the end of 2004.

CERTIFICATION

While these improvements have been embraced by small airplane manufacturers, large airplane manufacturers continue to oppose, at all levels of the rulemaking process, the strengthening of icing certification regulations, saying improved standards for large airplanes are unnecessary. The lack of fatal large airplane accidents which are conclusively attributed to inflight icing is the only data that has been presented to support exclusion of large aircraft. ALPA supports uniform safety standards for all aircraft, and opposes exclusions based solely on accident history.

INFLIGHT ICING FORECASTING

Under the leadership of the US National Center for Atmospheric Research and others, inflight icing forecasting has improved and experimental products are available on the World Wide Web for operational use. Resolution is still not sufficient for many operational decisions and methods of delivering updated products to the cockpit for real-time decision making are in their infancy. Operational benefits of current technology are hard to identify, but as refinement of current systems progresses and use increases, operational benefits will increase.

INFLIGHT ICING FORECASTING

ALPA believes that reasonable progress has been made in improving the resolution of icing forecasts, and as inconsistencies between certification and operations are eliminated, further use and benefit of the improved forecast icing products will occur.

OBJECTIVE INDEX OF INFLIGHT ICING

On May 7, 2003, the FAA published the final version of revisions to icing terminology for use throughout FAA publications. Light, moderate, heavy and severe accumulation rates on "the outer wing" are defined and "can be measured by a suitable icing rate meter."

ALPA believes these definitions are a good step towards meaningful information exchange between weather, air traffic control and operational users. However, until icing rate meters are developed and installed, and the factors which affect ice accumulation can be applied to icing definitions, pilot icing reports and forecasts of icing intensity and type will be of limited and inconsistent value.

A Serious Disharmony Between Certification and Dispatch / Operation

- Current certification only requires design for and demonstration of safe operation in Appendix C conditions. Safe operation in conditions which exceed Appendix C, including the larger droplets of freezing drizzle and freezing rain, is not required or addressed .

- FAR 121.629 (a) is very specific *"No person may dispatch or release an aircraft, continue to operate an aircraft enroute, or land an aircraft when in the opinion of the pilot in command or aircraft dispatcher (domestic and flag carriers only) icing conditions are expected or met that might adversely affect the safety of flight."*

- This rule can clearly be applied to prohibit operations in conditions that are not addressed in certification, conditions including freezing drizzle and freezing rain, that are outside Appendix C.

A Serious Disharmony Between Certification and Dispatch / Operation

- Pilots are directed by air carriers, in air carrier specifications and with no FAA objection, to takeoff and land in observed / reported freezing drizzle and freezing rain,

- The FAA continues to issue and approve misleading, confusing and subjective operational guidance, and

- Most pilots have no means of airborne identification of SLD (supercooled large droplets – all drops that exceed the 50μ upper limit of Appendix C) and no pilot has a reliable, technical means of SLD detection.

In The Nearly 9 Years Since The Roselawn Accident, Very Little Progress Resolving These Problems Has Been Made.

Takeoff and Landing in Freezing Drizzle and Freezing Rain

Air Carrier Operations Specifications

- An example:

  "Winter Operations Overview

  Flight into reported or forecast severe icing is prohibited.

  Takeoff during freezing drizzle and light freezing rain is permitted.

  Takeoff during moderate and heavy freezing rain is prohibited."

- Many other air carriers' FAA approved operations specifications simply state that takeoffs and landings are prohibited in moderate or greater freezing rain, or heavy freezing drizzle. Since they do not prohibit takeoffs and landings in the less severe conditions of light freezing rain, or light and moderate freezing drizzle, most air carriers conduct operations in these conditions.

Takeoff and Landing in Freezing Drizzle and Freezing Rain

Air Carrier Operations Specifications

- Why does the FAA not restrict air carrier flight operations in light and moderate freezing drizzle and light freezing rain - conditions that clearly exceed the certification basis of all aircraft? Why do air carriers feel these operations are safe (FAR 121.629)?

- The FAA's Ground Holdover Tables contain the only reference to operations in freezing drizzle or freezing rain in regulations, advisory circulars, or any related material. These tables are cited by air carrier operations personnel as the basis for limits on operations in freezing precipitation.

Takeoff and Landing in Freezing Drizzle and Freezing Rain

Ground Holdover Tables

Each year a Flight Standards Information Bulletin for Air Transportation (FSAT) containing “FAA-Approved Deicing Program Updates” is forwarded to all air carriers. These FSAT’s contain deicing fluid Ground Holdover Tables which are extracted and published by air carriers for aircrew use. The tables are part of each carrier’s FAA approved, ground deicing program. As an example, the 2002/2003 icing season FSAT, # 02-05, contains the following holdover table for Type II fluid:

FAA TYPE II HOLDOVER TIME GUIDELINE

TABLE 2 - Guideline for Holdover Times Anticipated for SAE Type II Fluid Mixtures as a Function of Weather Conditions and OAT.

CAUTION: THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRE-TAKEOFF CHECK PROCEDURES.

OAT		Manufacturer Specific Type II Fluid Concentration Neat-Fluid/Water (Vol. %/Vol. %)	Approximate Holdover Times under Various Weather Conditions (hours: minutes)						
°C	°F		Frost*	Freezing Fog	Snow◆	Freezing Drizzle***	Light Freezing Rain	Rain on Cold Soaked Wing	Other‡
above 0	above 32	100/0	12:00	0:35-1:30	0:20-0:55	0:30-0:55	0:15-0:30	0:05-0:40	CAUTION: No holdover time guidelines exist
		75/25	6:00	0:25-1:00	0:15-0:40	0:20-0:45	0:10-0:25	0:05-0:25	
		50/50	4:00	0:15-0:30	0:05-0:15	0:05-0:15	0:05-0:10	CAUTION: Clear ice may require touch for confirmation	
0 to -3	32 to 27	100/0	8:00	0:35-1:30	0:20-0:45	0:30-0:55	0:15-0:30		
		75/25	5:00	0:25-1:00	0:15-0:30	0:20-0:45	0:10-0:25		
		50/50	3:00	0:15-0:30	0:05-0:15	0:05-0:15	0:05-0:10		
below -3 to -14	below 27 to 7	100/0	8:00	0:20-1:05	0:15-0:35	**0:15-0:45	**0:10-0:25		
		75/25	5:00	0:20-0:55	0:15-0:25	**0:15-0:30	**0:10-0:20		
below -14 to -25	below 7 to -13	100/0	8:00	0:15-0:20	0:15-0:30				
below -25	below -13	100/0	**SAE Type II** fluid may be used below –25 °C (-13 °F) provided the freezing point of the fluid is at least 7 °C (13 °F) below the OAT and the aerodynamic acceptance criteria are met. Consider use of **SAE Type I** when **SAE Type II** fluid cannot be used.						

°C = Degrees Celsius
°F = Degrees Fahrenheit
OAT = Outside Air Temperature
VOL = Volume

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER.

* During conditions that apply to aircraft protection for ACTIVE FROST

** No holdover time guidelines exist for this condition below -10 °C (14 °F)

*** Use light freezing rain holdover times if positive identification of freezing drizzle is not possible

‡ Snow pellets, ice pellets, heavy snow, moderate and heavy freezing rain, hail

◆ Snow includes snow grains

CAUTIONS:

- THE TIME OF PROTECTION WILL BE SHORTENED IN HEAVY WEATHER CONDITIONS. HEAVY PRECIPITATION RATES OR HIGH MOISTURE CONTENT, HIGH WIND VELOCITY, OR JET BLAST MAY REDUCE HOLDOVER TIME BELOW THE LOWEST TIME STATED IN THE RANGE. HOLDOVER TIME MAY BE REDUCED WHEN AIRCRAFT SKIN TEMPERATURE IS LOWER THAN OAT.
- **SAE TYPE II** FLUID USED DURING GROUND DEICING/ANTI-ICING IS NOT INTENDED FOR AND DOES NOT PROVIDE PROTECTION DURING FLIGHT.

Effective: October 1, 2002

Takeoff and Landing in Freezing Drizzle and Freezing Rain

Ground Deicing Tables

- FSAT 02-05 also states in multiple places that:
  "*NOTE: The FAA does not approve takeoff in conditions of moderate and heavy freezing rain.*"
- This has led to the widespread belief that the FAA approves takeoff and landing (i.e. flight) in freezing drizzle and light freezing rain
- These are icing conditions that clearly exceed the certification basis of all aircraft flying today
- Pilots who refuse to takeoff in freezing drizzle and freezing rain, citing FAR 121.629(a), have been disciplined and face dismissal by their carrier

Takeoff and Landing in Freezing Drizzle and Freezing Rain

Ground Deicing Tables

Would you want the pilot of the aircraft you are flying in to takeoff or land in freezing drizzle or freezing rain?

Continued Publication and Approval by the FAA of Misleading, Confusing and Subjective Operational Guidance

Air Carrier Notice N8400.33
Flight Into Known or Forecast Severe Icing Conditions
10/30/02

Air Carrier Notice N8400.33
Flight Into Known or Forecast Severe Icing Conditions
10/30/02

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3. DISCUSSION. The National Transportation Safety Board (NTSB) presented a report to the Federal Aviation Administration (FAA) Administrator regarding the fatal accident of American Eagle flight 4184 at Roselawn, Indiana, on October 31, 1994.

a. The NTSB was concerned that unclear and inconsistent messages to pilots about the operation of aircraft certified for flight in icing conditions may create the misconception that flight in freezing drizzle and/or freezing rain is acceptable.

b. The NTSB stated that such confusing and apparently contradictory information could have contributed to a belief by Simmons Airlines/American Eagle management that dispatching and flying Aerospatiale/Alenia (ATR) 42 and 72 airplanes into conditions of freezing drizzle and light freezing rain was permissible. This belief was supported by the dissemination of a Simmons Airlines/American Eagle memorandum to its pilots in 1991 that set forth the conditions for flights into freezing drizzle and light freezing rain.

c. Severe ice is defined as the rate of accumulation of ice where deicing/anti-icing equipment fails to reduce or control the hazard. When encountering severe icing, immediate flight diversion is necessary.

NOTE: The FAA strongly recommends that air carriers not dispatch or conduct flights into KNOWN OR FORECAST SEVERE ICING conditions.

4.ACTION. Principal Operations Inspectors (POI)…

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This notice can be found at: http://www2.faa.gov/avr/afs/notices/

Continued Publication and Approval by the FAA of Misleading, Confusing and Subjective Operational Guidance

FAA Approved Airplane Flight Manual Instructions for the Boeing 737NG:

"The wing anti-ice system may be used as a de-icer or anti-icer in flight only. The primary method is to use it as a de-icer by allowing ice to accumulate before turning wing anti-ice on. This procedure provides the cleanest airfoil surface, the least possible runback ice formation, and the least thrust and fuel penalty. The secondary method is to use wing anti-ice prior to ice accumulation. Operate the wing anti-ice system as an anti-icer only during extended operations in moderate or severe icing conditions, such as holding. Ice accumulation on the flight deck window frames, windshield center post or on the windshield wiper arm may be used as an indication of structural icing conditions and the need to turn on wing anti-ice. Normally it is not necessary to shed ice periodically unless extended flight through icing conditions is necessary (holding)."

These are the only manufacturer's instructions for in-flight use of the wing icing system

FAA Approved Airplane Flight Manual Instructions

"The wing anti-ice system may be used as a de-icer or anti-icer in flight only. The primary method is to use it as a de-icer by allowing ice to accumulate before turning wing anti-ice on. This procedure provides the cleanest airfoil surface, the least possible runback ice formation, and the least thrust and fuel penalty. . ."

Questions:

- When using the primary method, as a de-icer, how much ice should be allowed to accumulate before turning wing anti-ice on?
- How long should it be left on?
- How long should it be left off before it is activated again?

FAA Approved Airplane Flight Manual Instructions

"...The secondary method is to use wing anti-ice prior to ice accumulation. Operate the wing anti-ice system as an anti-icer only during extended operations in moderate or severe icing conditions, such as holding. ..."

Questions:

- What are extended operations - all holding?
- How does a pilot determine moderate or severe icing conditions? Is all holding to be considered moderate or severe icing?

For Reference, the AIM definitions of moderate and severe icing are:

"Moderate: The rate of accumulation is such that even short encounters become potentially hazardous and use of deicing/anti-icing equipment or flight diversion is necessary

Severe: The rate of accumulation is such that deicing/anti-icing equipment fails to reduce or control the hazard. Immediate flight diversion is necessary."

FAA Approved Airplane Flight Manual Instructions

"... Ice accumulation on the flight deck window frames, windshield center post or on the windshield wiper arm may be used as an indication of structural icing conditions and the need to turn on wing anti-ice. Normally it is not necessary to shed ice periodically unless extended flight through icing conditions is necessary (holding)."

Questions:

- How can the system be used as a de-icer if it is turned on whenever the pilot observes ice accumulating?
- What is normal?
- Should the system be used as a de-icer in holding?

Most Pilots Have No Means of Airborne Identification of SLD, and No Pilot Has a Reliable, Technical Means of SLD Detection.

- Pilots of aircraft with pneumatic boots and non-powered roll control systems are told to look for side window ice or one of the following (AD 96-09-25)
  - *Unusually extensive ice accreted on the airframe in areas not normally observed to collect ice*
  - *Accumulation of ice on the lower surface of the wing aft of the protected area*
  - *Accumulation of ice on the propeller spinner farther aft than normally observed*
- Specific instructions regarding SLD, including SLD indications, are not even presented to pilots of most aircraft
- The airframe, other than the wind screen, and wing surfaces of many aircraft are not visible from the cockpit
- Tail surfaces are never visible

For these reasons, pilot determination of SLD while airborne is usually not possible

Conclusion

Since the Roselawn Accident in October of 1994, slow but positive progress towards the objective of safe flight in icing conditions has been made in the areas of:

Aircraft Icing Certification

Inflight Icing Forecasting

An Objective Index of Inflight Icing

However!!!

Conclusion

Little progress has been made towards resolving the following issues:

The serious disharmony between air carrier aircraft certification and dispatch / operation

Takeoff and landing in freezing drizzle and freezing rain

Continued issuance and approval of misleading, confusing and subjective operational guidance

No reliable method of airborne identification of SLD for most pilots

Air Carrier Pilots are NOT Being Provided the Operational / Regulatory Support and The Tools They Need to Operate Safely in the Known Hazard of In-Flight Icing which Exceeds the Certification Basis of Their Aircraft

Pilots Need:

Objective Guidance Based on Certified Aircraft Capabilities,

And

The Tools to Detect Icing Conditions that Exceed the Certified Capability of their Aircraft

Questions?